

Vol. 20

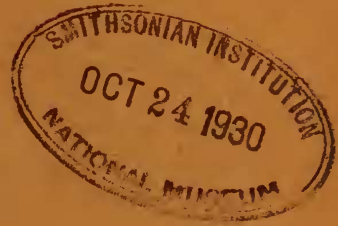
OCTOBER 19, 1930

No. 17

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES



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BY THE

WASHINGTON ACADEMY OF SCIENCES

MT. ROYAL AND GUILFORD AVES.

BALTIMORE, MARYLAND

Entered as Second Class Matter, January 11, 1923, at the post-office, at Baltimore, Md., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in section 1103, Act of October 3, 1917. Authorized on July 3, 1918.

Journal of the Washington Academy of Sciences

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GEOLOGY.—*Paleozoic formations in the Gold Hill quadrangle, Utah.*¹
THOMAS B. NOLAN, U. S. Geological Survey. (Communicated
by R. C. WELLS.)

Within the Gold Hill Quadrangle in western Utah, there is exposed a section of Paleozoic rocks that is comparable in thickness and in the time intervals represented to that at Eureka, Nevada.² The situation of the quadrangle (just east of the Nevada-Utah line and at the 40th parallel) about midway between the classic Nevada section and the well-known sections in the Wasatch³ and in the Tintic district⁴ makes this stratigraphic column of particular interest. In the present paper the Paleozoic formations that have been distinguished in the quadrangle are named and very briefly described, in advance of a more extended discussion which is to be published by the Geological Survey.⁵ Table 1 summarizes the section.

CAMBRIAN SYSTEM

Prospect Mountain quartzite.—The oldest formation exposed is a massively bedded quartzite that is identified with the Prospect

¹ Published by permission of the Director, U. S. Geological Survey. Received July 3, 1930.

² Arnold Hague. *Geology of the Eureka district, Nevada.* U. S. Geol. Survey Monograph 20. 1892.

³ F. F. Hintze. *A contribution to the geology of the Wasatch Mountains, Utah.* Annals New York Acad. Sci. 23: 85-143. 1913. F. C. Calkins. In *Ore deposits of Utah.* U. S. Geol. Survey Prof. Paper 111: 233-239. 1920.

⁴ G. F. Loughlin. *Geology and ore deposits of Tintic mining district, Utah.* U. S. Geol. Survey Prof. Paper 107. 1919.

⁵ *Geology and ore deposits of the Gold Hill quadrangle, Utah.* U. S. Geol. Survey. (Report in preparation.)

Mountain quartzite of the Eureka district.⁶ There are several thin shale beds in the upper part of the formation and lenticular conglomerates are rather abundant. Near the base of the formation as exposed in the quadrangle, there are several horizons of dark micaceous shale and some thin beds of dark quartzite that are interbedded with the normal quartzite. These shale horizons are well exposed along Basin Creek on the east front of the Deep Creek Mountains, 7 miles south of the southern boundary of the quadrangle.

The formation at this locality was estimated to be about 4,750 feet thick, divided as follows: (1) at top, quartzite, 2500 feet; (2) shale, 300 feet; (3) quartzite, 500 feet; (4) shale, 600 feet; (5) quartzite, 200 feet; (6) shale, 100 feet; (7) quartzite, 500 feet; (8) shale, 50 feet. No fossils were found in the formation, but, since it underlies conformably a Lower Cambrian formation, it is thought to be of the same age.

Cabin shale.—This formation, named from exposures in Cabin Gulch, south of North Pass Canyon, is composed dominantly of a dark green or khaki colored shale, which is only locally calcareous. Sandy laminae are abundant near the top of the formation, which grades, rather abruptly into the overlying Busby quartzite. The average of two fairly satisfactory measurements gave a thickness of 510 feet. A single fragmentary trilobite, found by Dr. Edwin Kirk, Jr., was submitted by Dr. C. E. Resser who reports that "the thoracic segment from Sheep Canyon, because of the sharp angle on its anterior side, seems pretty definitely to belong to a Mesonacid which would make it Lower Cambrian in the present usage of that term in the West."

Busby quartzite.—The basal 50 to 75 feet of the formation here named Busby quartzite is made of coarse-grained quartzite which contains in places tiny rock fragments in addition to quartz. Thin beds of dark quartzite and green sandy shale in varying proportions compose the remainder of the formation, the shales becoming increasingly abundant upwards. Mud cracks and fucoid markings are present in many of these beds. The top of the formation has been arbitrarily placed at the base of the lowest limestone bed, although quartzites and shales similar to those in the Busby are present above this line. The average of two closely accordant measurements indicates that the thickness of the formation is not far from 440 feet. No fossils have been identified from the formation but the gradational character of the contact with the overlying Abercrombie formation of

⁶ Arnold Hague. *Abstract of the report on the geology of the Eureka district, Nevada.* U. S. Geol. Survey Third Ann. Rept. 254. 1882.

Middle Cambrian age make it appear that the Busby quartzite is also of this age. The formation name is taken from Busby Canyon, on the northeast slope of Dutch Mountain, in which this formation is exposed.

Abercrombie formation.—The most characteristic type of lithology in the formation here named Abercrombie formation is a blue-gray dense limestone whose thin bedding is caused by thin bands or partings of

TABLE 1.—PALEOZOIC FORMATIONS IN THE GOLD HILL QUADRANGLE, UTAH

<i>System</i>	<i>Series</i>	<i>Formation</i>	<i>Thickness in feet</i>	
Carboniferous....	Permian	Gerster formation.....	600	
	Permian and Pennsylvanian.....	Oquirrh formation.....	8000±	
	Pennsylvanian (Pottsville) and Mississippian (?).....	Manning Canyon formation.	500±	
	Mississippian (upper)...		Ochre Mountain limestone...	4500±
			Woodman formation.....	1500±
	Mississippian (lower)	Madison limestone.....	0-400	
Devonian.....	Middle.....	Guilmette formation.....	900-1200	
		Simonson dolomite.....	1000	
		Sevy dolomite.....	450	
Silurian.....		Laketown dolomite.....	1000±	
Ordovician.....	Upper.....	Fish Haven dolomite.....	250	
	Lower.....	Chokecherry dolomite.....	0-1000±	
Cambrian.....	Upper.....	Hicks formation.....	600-1200	
		Lamb dolomite.....	1050	
	Middle.....	Trippe limestone.....	725	
		Young Peak dolomite.....	0-600	
		Abercrombie formation.....	2700	
		Busby quartzite.....	450	
	Lower.....	Cabin shale.....	510	
Prospect Mountain quartzite.		3000-4750±		

shale, which may be yellow, buff, pink or light gray. The limestone bands are from one-quarter to one-half inch thick. The shaly material is present only locally along many of the bedding planes and similar splotches of shale are found less commonly within the limestone and not parallel to the bedding. With increase or decrease in the amount of shale, the rock grades into lenticular shale beds or into relatively massively bedded limestones. Where best exposed the formation is

approximately 2700 feet thick. Almost all of the shale beds are fossiliferous. Dr. C. E. Resser of the National Museum divided the collections made into two groups. One of these, from the lower portion of the formation, contained *Bathyriscus productus*, *Zacanthoides* sp, *Obolus* sp, *Linguella* sp, and *Hyalithes* sp. He writes: "This seems to be the lowest horizon secured. The fauna corresponds with the Chisholm and Ophir." From the other group, *Elrathia* sp, *Paterina* cf. *utahensis*, *Micromitra* sp, *Obolus* sp, and Fucoids were recognized. This group he considers as Middle Cambrian, somewhere in the lower part. Abercrombie Peak on the ridge south of Dry Canyon is underlain by the formation.

Young Peak dolomite.—At the southern end of the quadrangle the formation here designated as Young Peak dolomite consists of 600 feet of massive dark gray to black crystalline dolomite spangled with short white rods of dolomite. Hand specimens of the rock are identical with those from the Bluebird dolomite at Tintic.⁷ As the formation is followed to the north, however, the dolomite interfingers with shaly limestones similar to those in the Abercrombie formation. Less than 5 miles to the north only a few feet of dolomite can be found, and the stratigraphic interval of the formation is occupied by portions of the Abercrombie formation. The upper contact of the formation is remarkably persistent in view of the characteristic lenticular habit of most of the Cambrian formations. This horizon, which marks the base of the overlying Trippe limestone, consists of a dark gray dolomite containing abundant nodules of dark gray chert which may reach several feet in diameter. It is overlain by a cream colored, finely laminated dolomite. These beds extend beyond the last remnants characteristic of the Young Peak dolomite. No determinable fossils were found in the dolomite, but it is undoubtedly of Middle Cambrian age. The dolomite is well exposed on Young Peak on the south side of Dry Canyon.

Trippe limestone.—This formation, named from exposures in Trippe Gulch on the south side of North Pass Canyon, is composed in large part of thin-bedded shale-mottled limestones similar to those that are so abundant in the Abercrombie formation. It contains in addition a few dark dolomite layers, beds of more massive limestone, and several horizons of finely laminated white dolomite and limestone. Most of the beds appear to be lenticular, since sections of the formation

⁷ G. F. Loughlin. *Geology and ore deposits of Tintic mining district, Utah*. U. S. Geol. Survey Prof. Paper 107: 28. 1919.

at different points fail to show similar sequences and thicknesses. The average of three measurements of the Trippe limestone is 725 feet. No fossils were found in any of these beds but the fact that much of it is lithologically similar to the Abercrombie formation makes it seem probable that it too is of Middle Cambrian age.

Lamb dolomite.—The lower third of the formation, here named Lamb dolomite is made up largely of thick-bedded oolitic and pisolitic dolomites, some of which are cross-bedded. Above this lies thick-bedded medium gray dolomite that is mottled by patches of dolomite containing white rods and resembles closely parts of the Young Peak dolomite. In the upper 150 feet thinner bedded dolomites with sandy partings become increasingly abundant and these grade upwards into a sandstone weathering reddish-brown that was chosen to mark the upper limit of the formation. This sandstone lenses out to the north but a similar lens starts at about the same locality a short distance higher stratigraphically. The Lamb dolomite is 1050 feet thick. Although no fossils were collected from it, its age is thought to be Upper Cambrian, since it is similar lithologically to the overlying Hicks dolomite, which is definitely of this age. The formation is exposed in Lamb Gulch, on the north side of Dry Canyon.

Hicks formation.—The greater part of the beds here named Hicks formation consist of dolomites similar to those in the Lamb dolomite, but the formation also contains lenticular beds of sandstone, fossiliferous limestone, and, in one place, shale. Two collections of fossils from one of the limestones were reported by Doctor Resser to contain *Pseudagnostus* sp., *Dunderbergia* sp., *Obolus* sp., and *Acrotreta* sp. He reports that these represent a lower Upper Cambrian horizon. The thickness of the formation varies from 1200 feet to less than 600 feet, the more southern sections being the thinner. This decrease in thickness is found within a strike distance of $3\frac{1}{2}$ miles and is thought to indicate an erosional unconformity between the Hicks formation and the overlying Chokecherry dolomite, of Lower Ordovician age. The same is taken from Hicks Gulch in North Pass Canyon, in which the formation is well exposed.

ORDOVICIAN SYSTEM

Chokecherry dolomite.—This formation is characterized by the presence of considerable silica, found both as nodules and bands of chert, usually dark gray to black in color, and as sandy laminae between thin beds of dolomite. The lower beds are, as a rule, rather massively

bedded chert-bearing dark-mottled dolomite, locally oolitic and cross-bedded, and containing thin lenses of dolomite conglomerate. These beds are supplanted higher in the formation by thinner-bedded dolomite with sandy laminae, or, locally, by bands of dark chert. A single collection of fossils from near the top of the formation contained only *Scaevogyra* (?) sp. Dr. Edwin Kirk, Jr., who identified it, reports: "The few gastropods in this lot do not permit exact age determination, and as yet we know of no other horizon with which it may be correlated. It may safely be considered as early Lower Ordovician, however." The formation is exposed only in the southern third of the quadrangle where its thickness ranges from 850 feet to more than 1,000 feet. In the northern part of the area it is entirely absent,—the overlying Fish Haven dolomite resting directly upon Upper Cambrian beds. There must, therefore, be a pronounced unconformity above the formation. The formation takes its name from the exposures in Chokeycherry Canyon just south of the southern boundary of the quadrangle.

Fish Haven dolomite.—This formation contains the same fauna, of Upper Ordovician age, as the typical Fish Haven dolomite of northeastern Utah,⁸ and has therefore been given the same name. It is composed of medium to thick-bedded dolomite, usually dark gray in color, and with but little chert. In general the mottling and other textures found so abundantly in the formations above and below are lacking. In the northern part of the area, the basal bed is full of small silicified brachiopods (*Rhynchotrema argenturbica*) and is very readily recognized. The formation preserves a remarkably constant thickness of about 250 feet throughout the quadrangle, although its contact with the overlying Silurian Laketown dolomite is wavy in detail. The following species were recognized by Doctor Kirk in the fossil collections from the formation: *Halysites gracilis*, *Streptelasma trilobatum*, *Streptelasma* sp., *Columnaria* sp., *Calapoecia* cf. *anticostiensis*, *Rhynchotrema capax*, *Rhynchotrema argenturbica*, *Dinorthis subquadrata*, *Zygospira recurvirostris*.

SILURIAN SYSTEM

Laketown dolomite.—The lower half of the formation is dark gray and rather massively bedded. Many beds are mottled or laminated and intraformational conglomerates are numerous. This zone is locally very fossiliferous, one bed about 100 feet above the base being

⁸ G. B. Richardson. *The Paleozoic section in northern Utah*. Am. Jour. Sci. (4) 36: 409-410. 1913.

full of the pentameroid brachiopod *Virgiana* sp. Above the dark dolomite is 350 to 400 feet of medium-gray, massively bedded dolomite. This horizon is almost lacking in fossils and has none of the textural features so abundant in the lower beds. It is succeeded by 150 to 200 feet of dark gray to black dolomite containing large numbers of silicified fossils, particularly corals. At the top is locally found a medium to light gray coarsely crystalline dolomite, which is sparingly fossiliferous. The upper contact of the formation is an unconformity, the overlying Sevy dolomite containing scattered boulders of the Laketown dolomite in its basal beds, and in several places, occupying depressions in the older rock. The only complete section of the formation measured 970 feet, but its thickness is obviously variable, since different horizons have been found at the contact with the overlying Devonian formation. Edwin Kirk, Jr., has examined a number of fossil collections from the beds herein identified as the Laketown dolomite, and reports that "This formation may be considered of Niagaran age. It correlates in part with the Fuselman limestone of Texas and New Mexico, the Laketown dolomite of northern Utah, and probably the upper portion of the Lone Mountain limestone of the Eureka district, Nev."

DEVONIAN SYSTEM

Sevy dolomite.—The Sevy dolomite, well exposed in Sevy Canyon on the western side of the Deep Creek Range, is remarkably homogeneous in its character throughout the area of outcrop. The typical rock is a well bedded, light mouse-gray dolomite in layers 6 to 12 inches thick, which weathers to a very light gray color. It is extremely dense and shows, on breaking, a conchoidal fracture. Most of the beds show a faint lamination parallel to the bedding. The formation contains a few beds of darker dolomite near the top and locally beds containing tiny nodules of light-colored chert. The basal bed of the formation is conglomeratic, as noted above. The only fossils found in the Sevy dolomite, which is about 450 feet thick, were a few crinoid stems and some poorly preserved gastropods, neither of which, according to Edwin Kirk, Jr., were in any way diagnostic. The formation is, however, gradational into the overlying Middle Devonian Simonson dolomite, and is presumably of the same age.

Simonson dolomite.—The characteristic rock of this formation is a dark to medium gray dolomite in which the individual grains are sufficiently large to be distinguished by the unaided eye. Individual beds are from 1 to 2 feet thick. The most striking feature of these

dolomites is the general presence of a fine lamination which is commonly extremely irregular in detail. Two non-persistent dolomite conglomerates are found within the formation and a third, which persists throughout the outcrop of the formation has been chosen to mark the upper boundary. The fossil evidence available, however, indicates that the time break represented is unimportant. The average of two measurements of the thickness of the formation is very close to 1,000 feet. Three lots of fossils collected were examined by Doctor Kirk, and were considered by him to prove the Middle Devonian age of the formation. He recognized the following species:—*Favosites* (digitate form); *Bellerophon* sp.; *Stringocephalus burtoni*; *Martinia* cf. *meristoides*; *Atrypa reticularis*.

The formation takes its name from the exposures in Simonson Canyon on the western side of the Deep Creek Range.

Guilmette formation.—This formation, named from exposures in Guilmette Gulch, is composed chiefly of dolomite but contains also a number of thick limestone beds and several lenticular sandstones. The dolomite that is most characteristic is a fine-grained rock, dark to medium gray on fresh fracture and weathering to lighter shades of gray and containing numerous vugs almost completely filled with white coarsely crystalline dolomite. Less abundant but far more striking are dark dolomites filled with fragments of tubular corals. Most of these contain a coral of small diameter (*Cladopora* sp.) but a number are filled with a larger branching variety (*Striatopora* sp.). The limestone beds differ from those lower in the section, being massively bedded, dense rocks that are light brownish gray on fresh fracture but weather to shades of bluish gray. The sandstone beds form a comparatively small part of the formation, but the brownish color they assume on weathering makes them conspicuous. Three measurements of thickness ranged from 1200 feet down to 890 feet, indicating that there is an unconformity between the Devonian and Carboniferous formations in this part of Utah. Several lots of fossils were submitted to Edwin Kirk, Jr., for identification. He identified: *Favosites* (digitate form); *Syringopora* sp.; *Stringocephalus burtoni*; *Atrypa reticularis*; *Martinia meristoides*; *Platyschisma* (?) cf. *mccoyi*; *Cyclonema* (?) sp.; and *Pycinodesma* sp. He writes: "The formation probably correlates with the Nevada limestone of the Eureka district in part. The horizon by virtue of the *Stringocephalus* may accurately be placed as high as Middle Devonian."

CARBONIFEROUS SYSTEM

Rocks of this age are by far the most widespread of the Paleozoic sedimentary rocks in the quadrangle. They have been divided into six formations, three of Mississippian, one of Mississippian (?) and Pennsylvanian age, one of Pennsylvanian and Permian age, and one of Permian age. Three facies of the Carboniferous have been distinguished. These have been brought into more or less close contact with each other by two large thrust faults; originally they were probably a number of miles apart. One of the three facies is represented by rather limited outcrops of only one formation,—the Woodman,—which overlies unconformably the older Paleozoic rocks. This may be called the *eastern facies*. It underlies the lower of the two thrusts and was the most easterly of the three facies. The second facies,—termed the *central facies* in this paper,—lies between the two thrusts. Three formations, the Ochre Mountain limestone, and the Manning Canyon and Oquirrh formations, are present in this facies. The third and last facies is the *western facies*, which contains representatives of all six formations. It lies above the upper thrust. The lithologic differences between the Manning Canyon and Oquirrh formations in this facies and in the central facies are striking.

Madison limestone.—This limestone on fresh fracture is a dull dark gray but weathers to a distinctly lighter gray color. The beds are moderately thin, ranging from three inches to a foot in thickness, the bedding being marked in many places by a concentration of pink or, less commonly, yellowish clay. Small amounts of similarly colored clay are also found within individual beds in some places, and the weathered surfaces of such beds have a faint pinkish mottling. At the top of the formation there are about 10 to 15 feet of more thickly bedded limestone, which contains numerous nodules of dark chert. Above this, apparently conformable, are sandstones of the Woodman formation. This formation was found only in the western facies, in which its lower limit was a thrust fault. The maximum thickness seen was about 400 feet. Several lots of fossils were collected and submitted to G. H. Girty of the Geological Survey. He reports that “there can be little doubt of the geologic age as lower Carboniferous and the correlation as with the Madison limestone.”

Woodman formation.—This formation, which underlies Woodman Peak on the south end of Dutch Mountain, consists of a lower division of dominantly calcareous sandstone and an upper one of sandy limestone. The sandstone division is roughly 200 feet thick and is gen-

erally poorly exposed. The beds are purplish or reddish brown, fine grained and contain a variable though small proportion of calcite as the cement. Thin lenses of limestone and shale are interbedded with the sandstone. The greater part of the upper division is made up of sandy limestone, which is dark gray to almost black on fresh fracture but which weathers to shades of light brown to pinkish. Nodules of dark gray to black chert are abundant and many be as large as a foot in diameter. Interbedded with the limestones and gradational into them are calcareous sandstones. A few beds of relatively pure limestone may also be found. No complete sections of this formation were found in any of the three facies, but it is probable that there is no great difference in thickness or lithology between the three. The thickest continuous section found measured 1,000 feet but the top was not exposed. The total thickness probably does not exceed 1500 feet, however. A large number of fossil collections were made from the formation and Doctor Girty, who examined them, writes that they indicate an upper Mississippian age.

Ochre Mountain limestone.—This formation takes its name from the fact that it is well exposed on Ochre Mt. It is composed almost entirely of massively bedded limestones, which are usually brownish gray on fresh fracture and weather to a light bluish gray color. Most of them are fine-grained, but there are local coarser beds. Individual beds may be as much as 10 feet in thickness and almost all are more than a foot thick. The basal few hundred feet of the formation includes beds that contain large amounts of chert, some beds being considerably more than half chert. The chert is generally light gray in color but weathers to a characteristic tan. About 1700 feet above the base of the western facies lies a thin and poorly exposed horizon of black shale interbedded with sandstone which is here named the Herat shale member from exposures near the Herat claims. No lithologic distinction could be made between the central and western facies of this formation. The thickness of the Ochre Mountain limestone was not accurately determined but it appears to be about 4500 feet. It is locally abundantly fossiliferous, and Doctor Girty reports that the fossil collections made prove that the formation, like the underlying Woodman formation, is of upper Mississippian age.

Manning Canyon formation.—Both the central and western facies of the beds here identified with the Manning Canyon shale of the Oquirrh Mountains are composed almost entirely of dark quartzites and sandy shales, and black shales. The first two are relatively more abundant in the central facies, and the latter in the western facies. • Limestone